EnVRonment: Time-Management and Stress Effects from Object Organization in Different Virtual Environments

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1 INTRODUCTION

Virtual reality (VR) has a wide range of applications because of the ability to create various and interactive environments. VR can simulate any environment or circumstances for specific purposes to get the result. Its ability to create complex and dynamic scenarios allows people to set any kind of test they desired, which makes it a valuable tool in research area. VR-based assessment system offers a wide range of benefits across the various domains [14]. As a result, using VR as an assessment tool is a feasible and straightforward way to observe the reaction of people completing specific tasks in designed environments. This makes it an efficient way to analyze results of an environment-based research project.

Since VR can be used to build virtual environments to mimic real-world situations, it can be a favorable approach to conduct complicated experiments. Experiments like cognitive abilities assessments can require long-term observation or resources to conduct the experiment in specific environments. This can be done more efficiently with VR due to the variability with choices to create your environment. VR holds great potential for enhancing cognitive ability assessments, especially in the fields of attention, problem solving, and executive function [11]. Similarly, VR has been found that it is a valid, dependable, and effective approach in evaluating cognitive performance [8]. Therefore, using VR as a tool to observe the reaction of individuals becomes an invaluable tool to conduct experiments and measure results.

Due to the fact that VR provides high quality result on cognitive assessment [8], we can seek to understand the influence of virtual environments on stress and cognitive ability. A major factor choice of environments in this experiment is color, which can impacts a participant's stress level and mood [5]. Some colors can make people feel more stressed, while others can help them relax. Environments designed with soothing colors, such as blues, can significantly lower stress levels, which can potentially improve cognitive functions like organization, memory, and attention [5]).

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Environments designed with stress-inducing colors, such as red, cannot only increase stress levels but could also lower the efficiency of cognitive processes involved in organizing and sorting tasks. This contrast highlights the fundamental psychological principles behind how different environments influence behavior and the management of stress.

As a result, combining body-based and computer-based methods can help explore a person's stress levels, influenced by the environment with different colors. The study is made realistic and immersive by the use of head movement as a technique of interaction in these virtual reality environments. This approach also provides a concrete way of measuring the effects of environmental changes on stress levels and organizational ability. Heart rate variability (HRV), galvanic skin response (GSR), and electroencephalography (EEG) is important in detecting stress, [15]highlighting the role of non-invasive methods for real-time measurement. This supports the objective of utilizing head movement and heart rates, especially with heart rates being useful for indicating stress levels.

2 RELATED WORKS

2.1 Cognitive Ability and Stress

Stressful scenarios can have a significant impact on cognitive function, whether that be positively or negatively. High stress environments might have negative effects on a person's function, which can influence their performance on tasks by lowering their cognitive ability.

General cognitive ability, often referred to as 'general intelligence', includes a variety of correlated abilities such as spatial and verbal abilities, information processing speed, and memory [9][12]. Our experiment is based on a participants ability to complete an organizational task, which includes core cognitive functions such as these. Looking at the effects of stress on cognitive ability can show how a stressful environment may impact a participant's success level in the organization task.

Researchers have found that individuals in harsh and unpredictable environments tend to be more present-oriented [3]. The observation shows a decrease in cognitive performance under various environmental stressors. That is, stressful environments make people feel uncomfortable, which give them a sense of uncertainty, resulting in reduced cognitive functions. However, some papers show an improvement in cognitive function under stressful environments. An example of this is shown in childhood cognitive ability. Some specific stressors, such as maternal health and social interaction can have impacts on a child's development and cognitive ability. [9]. Growing up in a stressful environment can sometimes enhance cognitive functions, such as shifting (efficiently switching between different tasks) in adulthood [7]. Stress is not always a negative force, as it is necessary for learning, and can be a positive aspect when it is under control[2].

Therefore, stress can sometimes be a beneficial way for people to learn, or it can hinder this process due to the state of mental or emotional strain and pressure[2][16]. These studies show the complexity of the relationship between stress and cognitive abilities. Stressful environments can either impair or enhance cognitive functions depending on types of stressors. It highlights the importance of understanding how stress impacts cognitive processes in different ways. Recognizing and understanding the complicated effects of stressful environments on cognition is crucial for educational, occupational, and health-related interventions

2.2 Environment Impact on Stress Level

Environment can be described in multiple ways, but we are focusing on the definition of environment being immediate and physical. A special kind of transaction or relationship between two systems, person and environment[10]. In

relating stress and environment, stress is the sources in the environment (the input or stimulus) and the person is on one hand, while the stress response or reaction on the other.[10].

The environment, both psychosocial and physical, has significant implications for behavior and affect [10]. Environmental conditions operate directly in the causation of stress reactions[6]. An important factor of environment includes sounds and noise. Previous works have shown when noise is associated with fear, found unnecessary, or the participant dislikes other parts of the environment, annoyance is heightened. [1] Physiological changes produced by noise are typically associated with stress responses [1].

Noise in addition to other environmental factors can cause the participant to feel discomfort and increase stress level. On the other hand, environmental factors have been proven to decrease stress levels. In a research study using virtual reality (VR) technology, the researchers show that natural environments have been largely employed in virtual environments aimed to promote stress reduction, for their widely studied and established ability to regulate stress and promote well-being [4]. It is important to understand the importance of environment on stress level. Whether that increases or decreases a participants well-being and state of stress.

3 RESEARCH METHODS

For this study, We created immersive environments using virtual reality (VR) to have participants complete an organizational task within that environment. We used Godot as our game engine with its powerful animation system and built-in coding language called GDScript. The four environments we made include two high stress environments: *Burning Building* and *Spooky House*, and two low stress environments: *Forest Oasis* and *Peaceful Beach*.

Using VR to create the environments allowed us to create different noises specific for each environment. Each scenario included noises closely relating with that environment, such as ocean waves for the *Peaceful Beach* and creaking floorboards for the *Spooky House*. Stress is commonly elicited through internal or external stimuli[16].

3.1 Virtual Reality Environments

Burning Building falls under the high stress environment category and included a scene where the participant is inside a burning building. Noises included are fire crackling, crashing, sirens, and people yelling. *Spooky House* is the second high stress environment and included the participant being inside a dark abandoned house with limited light and haunted house features. Noises included are creaking floors, slamming doors, and whispers. *Forest Oasis* is the first of the low stress environments. This is an open forest with sunlight and green trees. Noises included are birds tweeting and light breezes. *Peaceful Beach* is the second low stress environment where the participant is on a sandy beach with an ocean and beach items such as towels and rocks. Noises include ocean waves.

We chose nature environments for the low stress category because several lines of research have shown the potential of nature experience in positively affecting well-being and reducing stress[4].

3.2 Measurements

Stress is commonly assessed using subjective and objective measures. [16]. The subjective measure we used was heart rate variability through a heart rate tracker on the participants wrist. Short-term stress responses include cardiovascular reactions such as heart rate [1] which makes heart rate an important piece to consider regarding stress level. HRV is also shown to be an indicator for time related pressures or emotional strain on a person[13].

It is important to keep in mind the individual participants in this experiment and their personal responses. It is not always simple to decide whether stress arises from an environmental or external condition or from an internal personal

disposition, or from both [10]. To best gauge each individual's experience, we provided a survey before each trial and after each trial. Questions on this survey were focused on asking about the participants experience with gaming, their current mood, and their current stress level. This is how we measured the objective effects of each environment scene and its impact on the participant's stress level.

3.3 Procedure

We recruited 10 participants for this experiment and completed a within-subjects design. Each participant completed an organizational task from one of the high stress and low stress environments. To keep things concise, we paired one high stress environment with one low stress environment to create two pairs. Each participant completed one of the pairs.

The organizational task consisted of three categories of objects to sort. These three categories were clothing items, food items, and office supply items. Each category of items contained 5 different types of each item and these were randomly generated on the ground within the environment. The middle of each environment contained three bins with the category labeled on the bin. The participant's task was to navigate the environment, pick up the item, then bring it to the correct bin to sort. The participant is timed until all items were placed within a bin. Once the item is in a bin, it could not be moved. The same number of items were given to sort in each environment, randomly generated.

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